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ABSTRACT

This document is the executive summary for a two volume report on technological innovation and southern rural industrial development. The first volume examines public and private factors that influence investment decisions in new technologies and the outcomes of those decisions; effects of automation on employment and the workplace; outcomes of investment decisions; associated changes in organization and management philosophy; the role of education; and broader impacts on communities. Volume two is a collection of eight case studies. Most investments in automation are made incrementally to perform specific functions and address particular business objectives. Domestic competition and availability of new technologies are the two most common reasons for automating. Automation investments for these companies have increased capacity, output, productivity, and profitability. New technologies require more skills and flexibility, but provide for greater worker participation and autonomy. Automation is associated with higher-order thinking, more education, and more autonomy and responsibility for workers. Investments in new technologies typically lead to increases in total employment. Firms automating expect vocational education to provide sound basic skills and an ability to learn, rather than equipment-specific skills. Strategies for public sector intervention are suggested in the areas of outreach and information, education and training, and new industrial relationships. (DHP)

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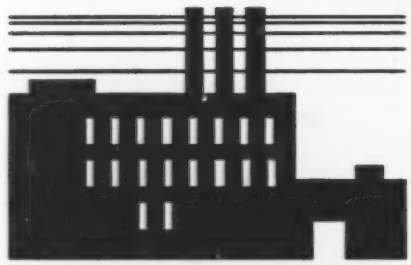
Executive Summary

Southern Growth Policies Board

REVIVING THE RURAL FACTORY



Automation and Work in the South

May 1988

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The Southern Technology Council is a newly formed, public/private advisory body to the Southern Growth Policies Board. Chartered in 1986 to enhance the development of technology within the region, the Council seeks to provide a regional forum for sharing ideas and strategies; to study the internationalization of technology and suggest state and federal policies; inform and educate state legislatures, government agencies, and the public regarding the importance, value, and effects of new technology; and facilitate the transfer of ideas to the marketplace by bringing together innovators with venture capitalists and business people.

The Council is composed of two members selected by the governor of each participating state, two members selected by the Executive Committee of the Southern Legislative Conference, and one member from each participating non-governmental entity.

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EXECUTIVE SUMMARY

Two years ago, the Southern Growth Policies Board, in its publication *After the Factories*, analyzed county employment patterns in the South between 1977 and 1982. It found, as expected based on macroeconomic trends and anecdotal evidence, that the growth of manufacturing employment, which had long been the driving force of the rural South's economy, had virtually ended. Increasingly intense competition from abroad and new criteria for business investments, such as increased emphasis on labor force talent and information services, had diminished the rural South's competitive advantage in costs and availability of labor. As a result, new jobs were accumulating in southern cities while many rural economies were declining. Manufacturing, however, provides a large share of the South's rural economic base, and the prospects for the rural South to switch to a service-driven economy without a strong production base seem very slim.

The South clearly needs new rural industrial development resources and strategies. Dramatic improvements in both productivity and quality within existing traditional industries are needed, and the one likely path is the adoption of new process technologies. The Southern Technology Council, formed in 1986 by the governors of twelve southern states under the auspices of the Southern Growth Policies Board, undertook the task of looking for ways to help rural manufacturers evaluate and utilize new technologies to become more competitive.

With a grant from the Rural Economic Policy Program (a joint program of the Ford Foundation, the Wye Institute, and the Aspen Institute for Humanistic Studies) and supplementary grants from the Hitachi Foundation and the Southern Education Foundation, the Council staff set out to investigate the current state of the automation of manufacturing and its impacts. Among its goals was to discover what the public sector is doing and can do to support and encourage investments in new process technologies in order to help make the rural industrial South more competitive.

Questions were framed around three areas of inquiry: *(1) public and private factors that influence investment decisions in new technologies and the outcomes of those decisions; (2) the effects of automation on employment and on the workplace;* and *(3) the broader impacts on communities.* Information obtained from reviewing relevant literature and research, identifying and surveying firms already using new technologies, and conducting intensive case studies at the site of eight respondents yielded a rich body of information from which to draw preliminary conclusions about automation in the rural South. The sample was not designed to be statistically representative but to provide a rough profile of automation in the rural South. To obtain the sample, state officials, university departments, community colleges, vendors of automated equipment, and trade associations were asked to submit names of rural, automated firms. The quest yielded a majority of large branch plants, with a median size of 400 employees. Small- and medium-sized manufacturers (under 100 employees) were underrepresented although they constitute more than 90 percent of all manufacturing firms in the South. Among the automated factories surveyed, smaller manufacturers constitute only 12 percent of the sample.

The report is organized into six sections: (a) extent and types of automation, in use and planned; (b) considerations and business outcomes of investment decisions; (c) effects on workers and employment; (d) associated changes in organization and management philosophy; (e) roles of education and training; and (f) impacts on communities.

Automation: The advantages of automation have been widely touted since the mid-century, when the computer and numerical control equipment (CNC) first arrived on the factory floor. The diffusion of new technologies, however, has been slow, and the equipment rarely met the expectations of its champions, the claims made in trade journals, or the sales pitches of equipment manufacturers. Further, since it was introduced in order to reduce skills and eliminate jobs, it was opposed by labor. In recent years, however, microelectronics has opened up new possibilities for automation, and the latest process technologies are more flexible, more affordable, and more promising.

New process technologies run the gamut from stand-alone computerized machines to fully integrated production systems. Examples are robotics; computer numeric control machines; automated material handling and packaging systems; flexible manufacturing cells and systems; computer-aided drafting, design, engineering and manufacturing; and computer-integrated manufacturing. Management, meanwhile, has discovered that it needs the cooperation and expertise of labor, and it has reorganized many factories in ways acceptable to the labor force. The following points about recent automation emerged from existing research, the surveys, and case studies.

- Most investments in automation are made incrementally to perform specific functions and address particular business objectives, and few rural sites have computer-integrated manufacturing systems. Most respondents perceive their own adoption of new technologies as lagging behind the average of firms in their industry group.

- Three-fourths of the firms surveyed plan significant investments in new technologies in the next two years and 86 percent report that their investments are part of a long-term strategy to modernize.

- On average, the Japanese-owned firms that responded use more extensive automation than other firms.

- The use of automated equipment made in other countries is quite common, as foreign companies have taken the lead in the production of robotics as well as other automated equipment.

- The 104 firms that responded to an initial survey indicated that the most widely used forms of automation in the rural South are CNC (62 percent), computer-aided manufacturing (53 percent), robots (33 percent), and computer-aided design (33 percent).

- The 51 firms responding to a more lengthy survey reveal that they use automation for a wide variety of functions, but that assembly (47 percent), material handling (47 percent), and fabrication (45 percent) are the most common applications. Most firms using new production technologies are also considering new management systems, such as just-in-time inventories.

Investment Decisions: With the competitive environment changing rapidly and with much of the rural South's industrial capital aging and growing obsolete, businesses constantly face decisions whether to invest in facilities and equipment. The media, trade journals, and salespeople bombard managers with information about new automated equipment that can cut costs, improve quality, and increase capacity. Public institutions have new and expanded programs designed to provide technical assistance and enhance technology transfer. What conditions prompt manufacturers to invest in new process technologies, where do they get their information, what factors influence their decisions,

and does automation have the expected outcomes for the company? The information from the background literature, surveys, and case studies suggests the following.

- Domestic competition (80 percent) and the availability of new technologies (73 percent) are the two most common reasons given for automating, while foreign competition is the third most cited reason (63 percent).

- Most managers expect their investments to reduce costs (94 percent), improve quality (86 percent), and increase capacity (77 percent). The case studies emphasize product quality and suggest that the major cost savings accrue from less set-up time, smaller in-process inventories, fewer rejects, and reduced waste, not primarily from labor.

- Rural business people consider vendors of equipment (64 percent) and sources within their own corporations (59 percent) their most important sources of information. The next most important sources are technical journals (31 percent) and business associates (20 percent). Few rely on universities (2 percent) or community and technical colleges (8 percent).

- Public sector programs and incentives such as tax breaks, education and training subsidies, and public capital programs do not have much bearing on the decisions. The case studies reveal, however, that the minimal effects may stem from perceptions that such incentives are available from most sites, and differences among states and localities are not great enough to influence decisions.

- The major obstacles to investments are costs (30 percent), shortages of finance capital (24 percent), and lack of the right technology (22 percent). Lack of labor, management expertise, or urban amenities do not significantly hinder investments.

- Among locational factors influencing investment decisions, overnight express (34 percent), access to telecommunications (28 percent), and proximity to airport (28 percent) are most important, although no single factor was ranked important by a majority of the respondents.

- No human resource factor ranks "important" to the investment decisions of a majority. Training programs are important to 36 percent, a skilled labor force is important to 33 percent, and professionals and scientists are important to 30 percent.

- Automation investments for the subject companies are almost universally positive. Capacity, output, productivity, and profitability increased, reflecting success in expanding markets or finding new markets.

The Changing Workplace: The effects on the workplace and on employment are perhaps the most widely debated aspect of automation. Ever since the Luddites fought the introduction of the power loom in nineteenth century England, automation has been seen as a threatening force rather than a liberating technology. Debates still rage between pessimists concerned that technology will degrade and de-skill work, rendering the operator obsolete, and optimists foreseeing an improved workplace with operators who are in control of their equipment instead of controlled by it. The latter base their optimism on the knowledge that automation is imperfect and requires frequent correction by operators; that manufacturing is becoming more flexible, requiring quicker responses to changes in production; and that operators are better educated and their experience and expertise are

more highly valued in emerging management systems. The literature, surveys, and case studies suggest the following conclusions.

- Respondents to the survey indicate that new technologies require more skills and flexibility and provide for greater participation and autonomy. The idea that production workers dealing with new technologies must be able to use their heads as much as their hands and that they must be willing to continually learn new skills are constant themes at the case study sites. As one manager puts it, "We're asking for the capability to think, the capability to reason, and the capability to get along with people."

- While experts debate whether automation increases or decreases skills, what really seems to be taking place is a re-skilling. Automation simplifies some functions, adds complexity to others, but also requires very different skills, such as an understanding of statistical process control and programming and an aptitude for problem-solving.

- The weight of evidence thus suggests that automation is indeed associated with higher-order thinking and more education, although this association often results more from management's new expectations than the minimum technical requirements of the equipment. In most factories, for example, operators are expected to adjust programs and perform minor maintenance and repairs, and such jobs are much more intellectually challenging.

- New generic skills associated with automation include manufacturing concepts, computer programming, and statistical process control. All require more understanding of math than most current workers have. Management in the automated plants studied also expect greater flexibility and understanding of the entire production process among their workers. Therefore, most plants invest heavily in adult basic education prior to further technical training.

- Employees were given more autonomy and responsibility, most often through control over the rate of production and input into decisions through some variation of quality circles. Only one of the plants, however, uses participation to the same extent as Japanese manufacturers. There were very few examples of employees directly influencing operating decisions.

- The automated factories studied generally are more pleasant working environments than traditional factories. They are cleaner and pose fewer hazards, and social relationships are less hierarchical and formal.

- In instances where management did not alter its style from traditional labor-intensive manufacturing, however, work consists primarily of monitoring the new equipment and seems far less interesting than manual labor.

- Good attitudes, a strong work ethic, and low wages remain among the most important attributes management seeks in workers, with automated or traditional equipment. Some managers interviewed cite the agriculture tradition as a positive and unique factor in both the work habits and technical aptitude of rural workers.

- In most plants wages, even for upgraded jobs, remain low compared to national scales.

- Investments in new technologies typically lead to increases in total employment (39 percent), usually because the investments are associated with expansions or new facilities. Few sites actually decreased employment. In some locations, however, investments in automation were associated with a corporate consolidation, and jobs at other locations not studied were eliminated.

- After automation, rural factories require relatively few operators with technical degrees. Just over half the respondents note a slight increase in technicians, and as indicated by the case studies, most opt to give existing employees a chance to retrain for the new positions.

- In most firms the introduction of new technology seems to provide equal employment opportunities for women and minorities.

- Although there are few displacements attributed to technology in this study, the case studies provide numerous examples of employees who turned down opportunities to learn new skills out of fear of failure, unwillingness to assume added responsibility, or lack of confidence. Most were given a chance to be reassigned to less demanding work.

New Organizational and Management Concepts: The role of management in selecting, introducing, and implementing new technologies is a major though often overlooked factor that directly contributes to the success or failure of technological change on the shop floor. The changing nature of the resources that industrial managers now find themselves supervising requires a different set of skills. Managers are rethinking the organization of work, definitions and classifications of jobs on the shop floor, approaches to labor relations, and their own roles in the new environment. The need for middle level managers, for example, diminishes when production workers take on greater responsibilities in the production process. In addition, production managers need to have greater technical skills and a better understanding of how automated technologies operate. Still, organizational changes are developed slowly, in part because automation has been introduced slowly and incrementally and in part because new ideas are inherently threatening. Information from the literature, surveys, and case studies suggest the following.

- Although branch plants predominated in the study, four-fifths of the respondents report that they perform process design on-site, which includes critical management choices concerning what equipment to use, how to use it, and who would use it.

- The survey responses at a majority of sites indicate that major organizational changes accompany the introduction of new technologies. Half of the respondents report that the number of job classifications among the direct labor force decreased due to automation, and more than half (58 percent) report that production workers' participation in decision-making has increased.

- To foster a greater sense of team among all employees, a number of plants studied indicate that they initiated practices to minimize hierarchical distinctions among the work force. These practices include using the title "technician" for all production workers; paying salaries rather than hourly wages; and using first names to address all managers and co-workers. Workers and managers at the case study sites share the sense that they are threatened by world competition and a willingness to adapt to the changes necessary to meet that threat.

- Among the survey respondents, the presence of a union does not appear to affect the success or failure of implementing technological change. Whether or not a plant was unionized appears to have no bearing on a plant's ability to respond flexibly to automation.

- Quality circles were found to be widely used to foster better communication between managers and workers, to identify productivity and quality improvements, and to help workers internalize the company goals of quality, cost efficiency, and productivity. The quality circles at the case study sites, however, are personnel practices rather than organizational changes and do not involve employees in decision making.

- Work-team development is an organizational change practiced at the newer, more automated case study sites. In this case, teams are given responsibility for lower level management functions such as materials and inventory, quality control, and in some cases even work and pay assessments.

- More than half of the survey respondents consider the availability of continuing education for managers unimportant to their decisions to automate. Case study interviews, however, provide a different picture. They indicate an acute awareness of the need for greater technical skills among managers. Lack of technical expertise among managers also is cited in case studies as a problem associated with automation.

Automation and Education Institutions: Public schools have the task of preparing youth for technological change. Given that public schools in the rural South historically have been underfunded and perceived as low quality, much of the reform and renewal of public education in the South has economic goals that are at least in part related to technology-based development. Perhaps the most successful educational support of technology has come from the South's strong system of community and technical colleges. Designed specifically to facilitate economic development, these schools give technical education a high priority. Also, the region's universities are facilitating technology transfer to manufacturers via a whole host of programs, including incubators, industrial extension, technical assistance, joint research and development, and continuing education. In addition to the public sector, sources for education and training on new process technologies include private training companies, vendors, and internal operations. In this large and diverse education and training enterprise, how are the region's institutions valued and used? What are the educational needs of firms investing in new technologies?

- The vast majority of training at the firms studied comes from within the company (98 percent) and from vendors (84 percent). About 41 percent use community colleges and only 10 percent use universities.

- When asked to rate the importance of education and training to investment decisions, only 30 percent note public elementary and secondary schools and 36 percent note training and retraining programs as important factors.

- Firms automating expect vocational education to provide sound basic skills and an ability to learn. They are not looking for equipment-specific vocational skills, and the schools cannot afford to keep their shops up-to-date with new process technologies.

- Public schools are frequently asked to make up for past neglect by providing remedial education from basic skills through GED preparation. The most

frequently needed and taught subject is basic math, beginning with simple operations on decimals and fractions. As one manager stated, "We had beautiful training programs and trainers, and we found it wasn't taking...We had to back up and teach remedial math, remedial English."

• Employers impressions of community colleges varied considerably. Some completely dismissed the community college as an important training source to one sites that obtained from the state a new community college branch facility built especially to meets its special training needs. In general, most firms do value the community colleges, although they rarely depend on them for their specialized training on new equipment.

• A program growing in popularity, especially with foreign-owned firms, is train-the-trainer. A small number of employees are sent to the corporate headquarters or to the vendor to become expert with the new technologies and learn how to train their co-workers. This is particularly important for Japanese firms in the study, which prefer that trainers be totally immersed in Japanese culture on-site in Japan.

State Strategies: The overarching goal of this project is to identify what public policies most effectively advance the transfer of new process technologies to manufacturers in the rural South. Effective government policies and programs would, presumably, improve the ability of southern manufacturers to compete in world markets . The public sector must do all it can to establish and support conditions that foster modernization, innovation, and productivity. The information gathered though the surveys and the case studies suggest appropriate areas for public sector intervention. They can be categorized within the three broad themes: (a) outreach and information; (b) education and training; and (c) new industrial relationships.

Strategy No. 1: Provide better information about new technologies targeted at small and medium-size firms: The project suggests that independent and small- and medium-sized manufacturers would benefit from better information about new process technologies. Dissemination of such information is a legitimate function of the public sector.

Strategy No. 2: Invest in research in manufacturing and in engineering. It is important to direct R&D toward those industries that are heavily concentrated in the rural South. THese industries may not be most glamorous and "high-tech," but are vital to many rural economies.

Strategy No. 3: Look to the local colleges to provide technical resources as well as education and training. Community and technical colleges are community-based institutions that have as part of their mission the economic development of their service area. They are an under-utilized resource that could do much more that they currently are.

Strategy No. 4: Support "train-the trainer" programs . One of the most exciting new programs is the training of a small number of company employees at the site of the vendor or parent company to learn about the equipment and how to teach their co-workers. Such programs should be encouraged and expanded.

Strategy No. 5: Establish Adult Basic Education that emphasizes the basics needed by manufacturers, e.g., mathematics, communications, and scientific methods. Much of the labor force serving existing rural manufacturers lacks the basic skills needed to implement new technologies. Programs to provide these skills to rural workers in advance of investments could make the investment less costly and less risky because it will not hinge on re-educating employees.

Strategy No. 6: Provide retraining and assistance to workers dislocated by changing technologies. Some workers are unable to adjust to the new technologies and require special attention. While most training prepares workers to understand and use new technologies, it is also needed to prepare others for new occupations, many in service industries.

Strategy No. 7: Provide management education in rural areas. The success of automation depends as much on the capabilities of management as on the skills of the work force, yet rural managers lack ready access to existing private programs. Programs offered locally or via computer hookups on the management of technology and management sciences are inexpensive and would prove effective offered in small, regular doses to isolated managers and small shop owners.

Strategy No. 8: Internationalize the curriculum of both public education and training. New foreign investments in the South and increasing reliance on foreign trade demand a better understanding of other economic systems and cultures. From the simple need to understand the metric system to understanding Japanese culture, training and retraining programs ought to prepare employees to deal with business people from other nations.

Strategy No. 9: Take stock of local producers and work with them to develop linkages to quality suppliers and component manufacturers. Increased out-sourcing of parts and quicker response times is leading to tighter relationships between producers and suppliers. Understanding and articulating the new relationships and aiming resources at developing regional networks is a new and important function for state and local development agencies.

Strategy No. 10: Establish networks among manufacturers to share the costs of information and services. One way to overcome diseconomies of scale among small firms is to share the costs of programs that are too expensive for individual independent firms. Joint applied research in production processes, technical training programs, and market information services are just a few of the services that could be shared by small firms in the same industrial sector.